Class:	Register No:	Name:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION

PHYSICS **6091/02**
Paper 2

28 Aug 2023

1 hr 45 min

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces provided at the top of this page and on all separate answer sheets used.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluids.

Section A (50 marks)
Answer **all** questions.

Section B (30 marks)
Answer **all** questions.
Question 11 has a choice of parts, answer **either one**.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	/50
Section B	/30
TOTAL	

Section A (50 marks)
Answer **all** questions. Write your answers in the spaces provided in the question paper.

1. A vernier calipers is used to measure the diameter of a small cylinder.

Fig. 1.1a shows a vernier calipers and Fig. 1.1b shows the main scale and vernier scale of the vernier caliper in detail.

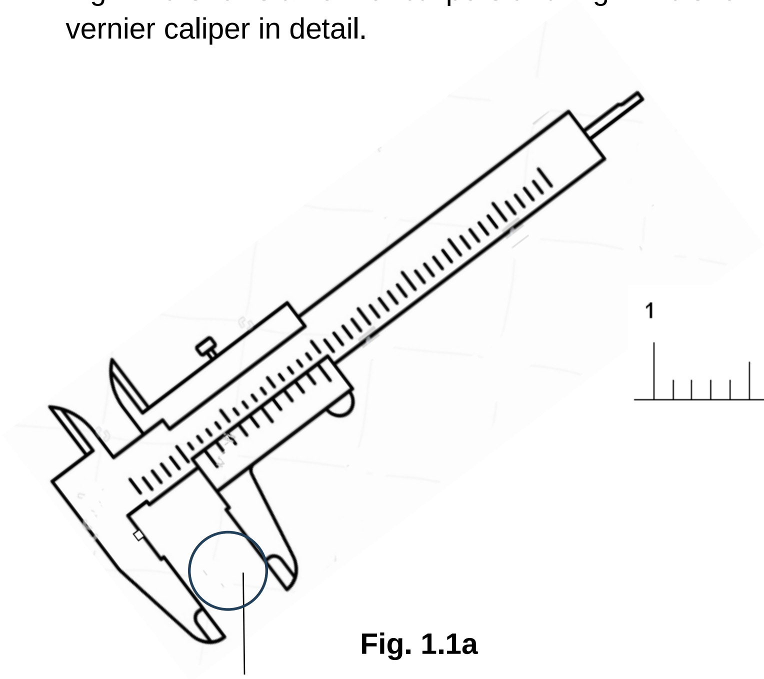

Fig. 1.1a

cylinder

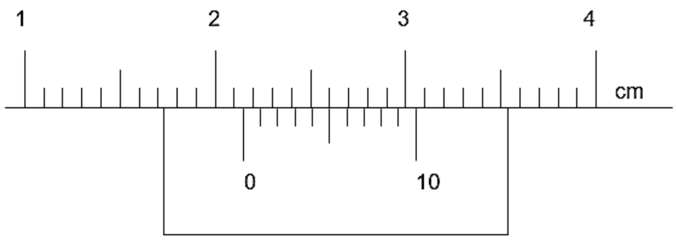

Fig. 1.1b

The reading for the diameter of the cylinder is 2.15 cm.

(a) **(i)** Describe how Fig. 1.1b shows that the reading is 2.15 cm. [2]

- **Main scale reading is 2.10 cm. vernier scale reading is 0.05 cm**
- **Add the two values together to obtain 2.15 cm.**

(ii) State one precaution taken to find an accurate value for the diameter of the cylinder. [1]

Check for zero error before using the instrument. Minus the zero error from the observed reading.

OR

Take a few diameter readings and find the average

(b) The length of the cylinder is 0.026 m and its mass is 4.0 g.
Calculate the density of the cylinder.

Volume = cross sectional area x length
= 3.14 x $(2.15/2)^2$ x 2.6
= 9.4345 cm^3

Density = mass / volume
= 4.0 / 9.4345
= 0.424 g/cm^3

density = ……………………… [3]

2. A gymnast jumps off from a high bar from A, lands on a trampoline at B and is in contact with the trampoline between B and C. D is the highest position reached by the gymnast as she rises. Fig. 2.1 shows the velocity-time graph for the gymnast. Air resistance is negligible.

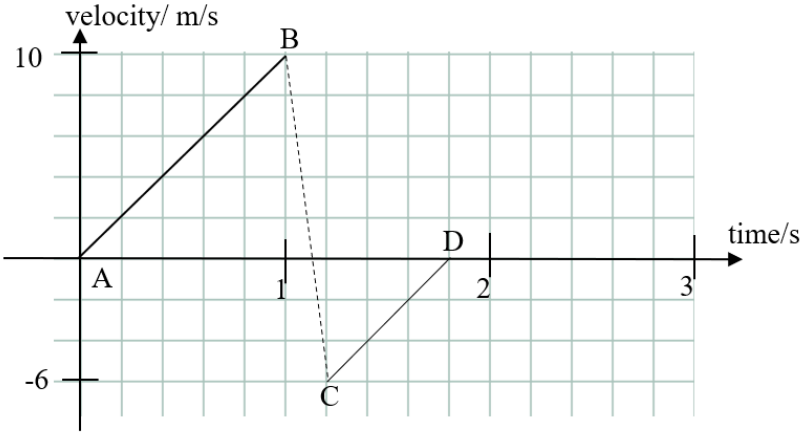

Fig. 2

(a) Table. 2 below is for the direction of motion of the gymnast and the direction of acceleration of the gymnast.

Complete Table. 2. [2]

	direction of motion of gymnast	direction of acceleration of gymnast
during AB	**downwards**	**downwards**
during CD	**upwards**	**downwards**

Table. 2

(b) Using the information from Fig. 2.1b, describe the motion of the gymnast between C and D. [1]

speed is decreasing at a constant rate/Constant deceleration

(c) State how Fig. 2.1 shows that the distance covered between A and B is larger than the distance covered between C and D. [1]

The area under the graph between A and B is larger than the area under the graph between C and D.

(d) Determine

1 the change in speed of the gymnast between B and C: **-4.0 m/s or 4.0 m/s** [1]

2 the change in velocity of the gymnast between B and C: **16 m/s or -16 m/s** [1]

3. Fig. 3 shows a section of the roller coaster track in Universal Studios at Sentosa.

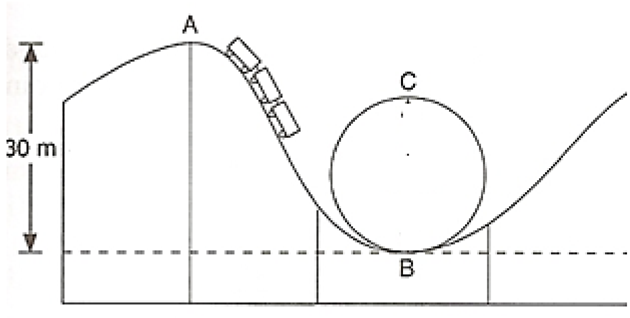

Fig. 3

The total mass of the roller coaster and its passenger is 1000 kg. The speed of the roller coaster at A is 20 m/s. B and C are the bottom and top points of a vertical loop respectively. A is 30 m above B. The roller coaster travels 250 m from A to B and the speed is 22 m/s when it reaches B.

(a) State what is meant by the *Principle of Conservation of Energy*. [1]

The Principle of Conservation of energy states that energy cannot be created or destroyed, but can be converted from one form to another. The total energy in an isolated system remains constant.

(b) Calculate the kinetic energy of the roller coaster at B.

k.e = $\frac{1}{2}mv^2$

= $\frac{1}{2}\ x\ 1000\ x\ 22^2$

= 242 000 J

kinetic energy = ……………………… [2]

(c) Calculate the work done against friction from A to B.

total energy at A = total energy at B + work done against friction

GPE at A + ke at A= ke at B + work done against friction

(1000 x 10 x 30) + (0.5 x 1000 x 20^2**) = 242 000 + W.D against friction**

Work done against friction = 258 000 J

work done = ……………………. [2]

4. Fig. 4 shows a ray of light PQRS as it enters and leaves a semi-circular glass block.

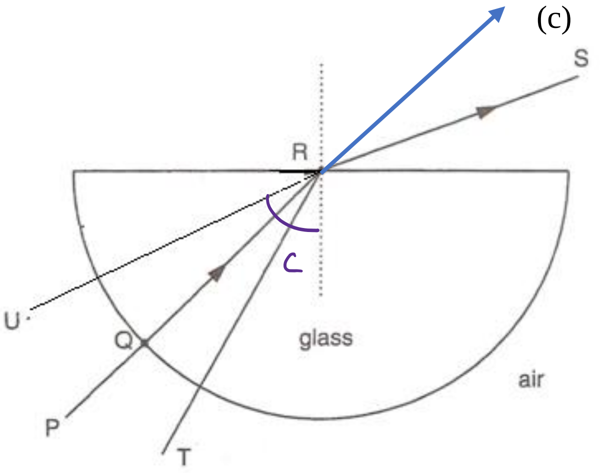

Fig. 4

The speed of light in air is the same as the speed of light in a vacuum, which is 3.0 x 10^8 m/s.
The refractive index of glass is 1.5.

(a) Explain why there is no change in the direction of the ray as it enters the block at Q. [1]

The angle of incidence is 0º, hence angle of refraction is also 0º.

(b) Calculate the speed of light between Q and R.

n = c / v
1.5 = (3 x 10^8) / v
v = 2.0 x 10^8 m/s

speed = ………………………… [2]

(c) Another ray passes along TR. On Fig. 4, draw this ray as it leaves the block at R. [1]

- **Has a smaller ∠r compared to ray RS**
- **Must have arrow**

(d) A third ray passes along UR and some of the light emerges into the air at R along the surface of the block.

(i) On Fig. 4, label the critical angle *c*. [1]

(ii) The block is replaced by another block which has a higher refractive index.
State and explain what happens to ray UR at R now. [3]

- **The new block has a smaller critical angle.**
- **Angle of incidence is now greater than critical angle, and ray is travelling from optically denser to optically less dense medium,**
- **ray UR will now undergo total internal reflection.**

5. Fig. 5 shows a negatively charged metallic sphere held with an insulated handle. The sphere is brought near an earthed metal plate attached to a galvanometer via a copper wire.

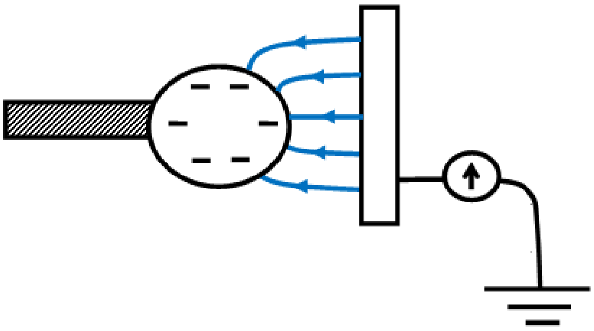

Fig. 5

(a) On Fig. 5, draw the electric field set up between the sphere and the metal plate. [2]

(b) Explain what happens to the charges on the metal plate when the charged sphere is brought near the metal plate. [2]

- **As like charges repel,**
- **the negative charges of the plate will move away from the charged rod / move to the right and/or flow down the copper wire.**

(c) Suggest one method to increase the momentary deflection of the galvanometer. [1]

Use a sphere with a greater negative charge

OR

Bring sphere closer to the plate

(d) The sphere is now replaced with an identical metal sphere that is positively charged and brought near the metal plate. State any changes to the deflection on the galvanometer. [1]

The galvanometer will deflect in the opposite direction/to the right.

6. Fig. 6 shows a light dependent resistor (LDR) and a battery of e.m.f 6.0 V connected in a circuit. When no light falls on the LDR, its resistance is 3.6 kΩ. In dim light, its resistance is 1.2 kΩ. The maximum resistance of the potential divider, AB, is 600 Ω. The slider X is at the midpoint of AB.

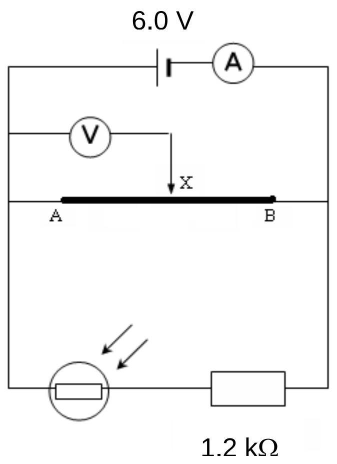

Fig. 6

(a) State the potential difference across AB. [1]

6.0 V

(b) If no light falls on the LDR, calculate

(i) the total resistance in the circuit,

$$\frac{1}{R_T} = \frac{1}{600} + \frac{1}{4800}$$

$$R_T = 533\Omega$$ **[1]**

resistance - …………………………….. [1]

(ii) the reading on ammeter A.

$$I = \frac{V}{R}$$

$$I = \frac{6.0}{533.33}$$

$$I = 0.011A$$ **[1]**

ammeter reading = ………………………. [1]

(c) Determine the potential difference across the LDR when the entire circuit is placed under dim light.

p.d across LDR $= \frac{1200}{1200+1200} \times 6.0$

$= 3.0V$

potential difference = ……………………….. [2]

(d) State and explain what happens to the voltmeter reading when the slider X is shifted toward point A. [2]

When the slider moves towards A, resistance across AX decreases.

Hence the voltmeter reading decreases to zero.

7. Fig. 7.1 shows a coil of wire C connected to a switch and a strong battery. The coil of wire is wound round a hollow cylindrical tube G made of paper.

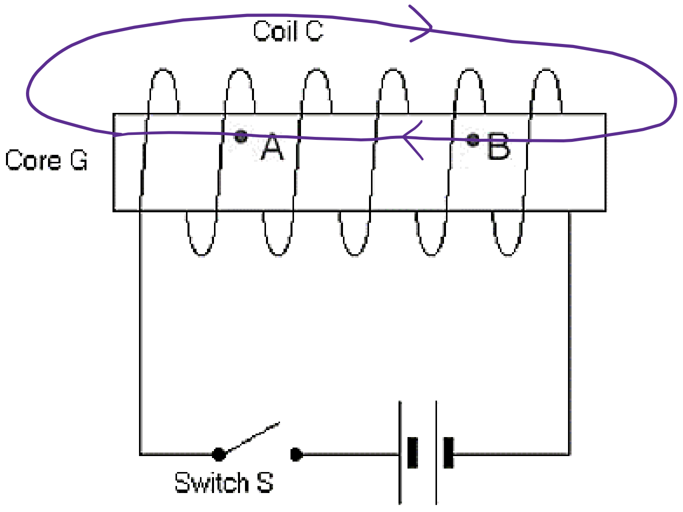

Fig. 7.1

When the switch is closed, the current in the solenoid creates a magnetic field.

(a) A magnetic field passes through A and B.
On Fig. 7.1, draw this magnetic field line both inside and outside the solenoid.
Draw an arrow on the line to show the direction of the magnetic field. [1]

(b) A compass is now placed at the right end of the coil as shown in Fig. 7.2. The North pole of the compass is pointing in the direction shown.

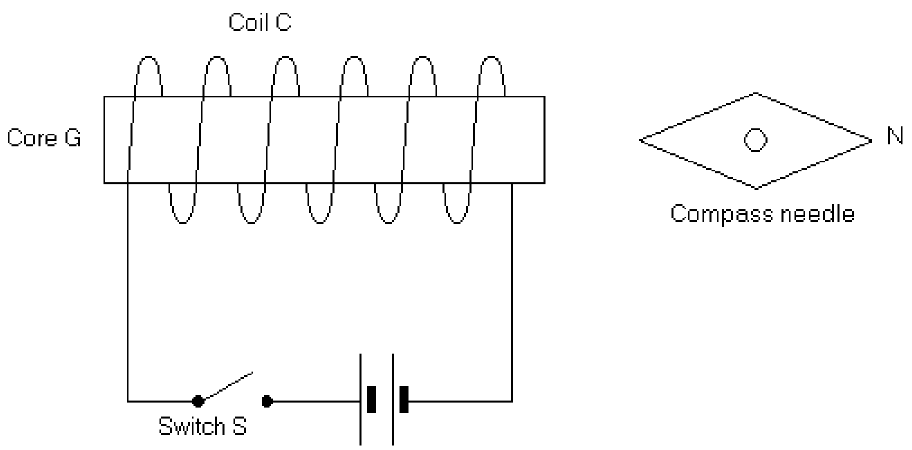

Fig. 7.2

(i) State what happens to the North pole N of the compass needle when the switch is closed. [1]

Turns so that its north pole faces the coil.

(ii) If the paper core G is replaced with a piece of steel, state and explain what happens to the compass needle when the switch is closed and then opened after some time. [3]

When switch is closed, the compass north turns to face coil
When the switch is open, the compass north remains facing coil
This is because steel retains its magnetism.

8. Fig. 8.1 shows the structure of a simple a.c. generator. The coil is currently in a horizontal position and turns at a constant speed.

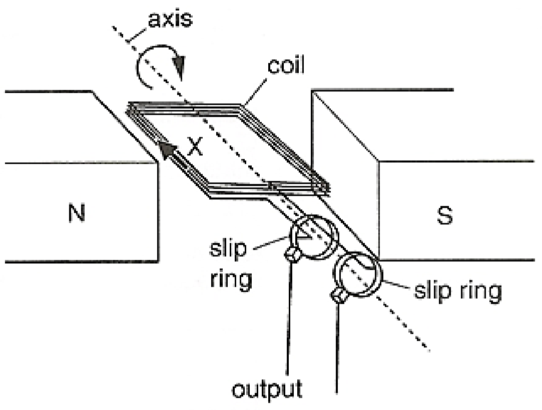

Fig. 8.1

(a) When the coil is rotated, an e.m.f is induced in the coil.
Explain why an e.m.f. is induced. [2]

- **When the coil rotates, it cuts the magnetic field lines.**
- **The change in magnetic flux (linkage) in the coil produces an induced emf in the coil.**

(b) A resistor is connected to the output. On Fig. 8.1, an arrow indicates the direction of the current at point X.

Explain how a current in this direction opposes the rotation of the coil. [2]

- **The magnetic field of the induced current interacts with the magnetic field of the permanent magnet.**
- **A downward force on the left side of the coil and/or anticlockwise moment is produced, which oppose the clockwise rotation of the coil.**

(c) Fig. 8.2 shows how the output voltage of the generator varies with time.

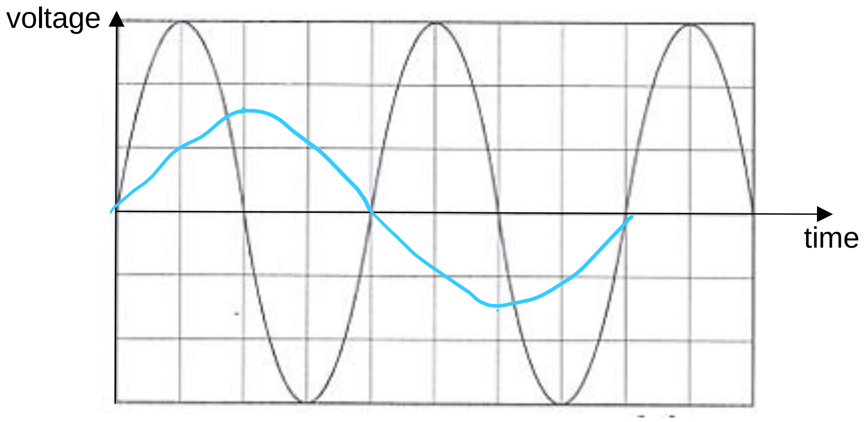

Fig. 8.2

(i) Describe the position of the coil that produces a zero induced e.m.f.

vertical

(ii) The coil is now rotated at half the original speed.
On Fig. 8.2, draw a graph to show how the output voltage varies with time when the coil is rotated at half the original speed. [2]

Section B (30 marks)
Question 11 has a choice of parts, answer **either one**.
Write your answers in the spaces provided in the question paper.

9. Fig. 9 shows two of the towers that support a single cable of total length 5.0 km, which links a factory to the electrical grid.

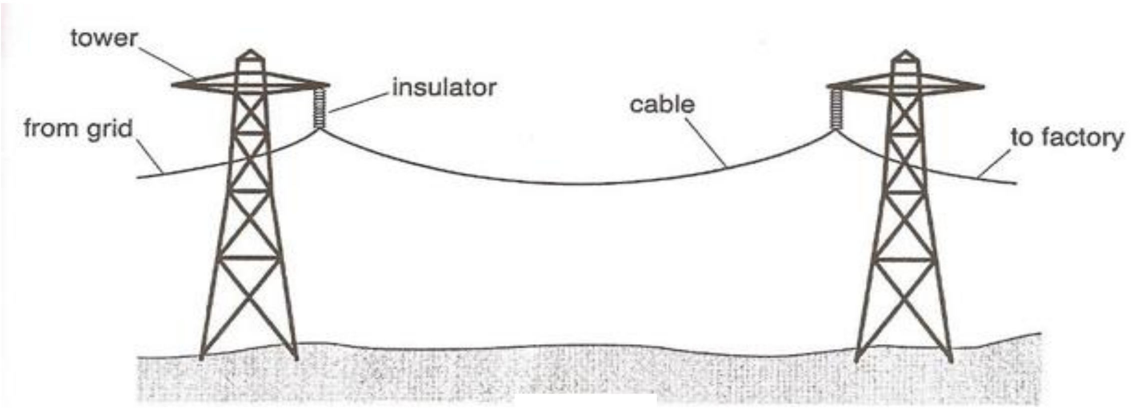

Fig. 9

If the weight of the cable between two towers is larger than a given force *F*, then the cable breaks. The value of *F* depends on the material from which the cable is made. The table gives the value of *F* and other data for three cables made from different materials.

cable	material	F / N	$\frac{\text{resistance of 1km}}{\Omega}$	$\frac{\text{density}}{\text{kg/m}^3}$	$\frac{\text{cross-sectional area}}{\text{m}^2}$
1	aluminium	6000	0.075	2700	3.0×10^{-4}
2	copper	9000	0.050	8900	3.0×10^{-4}
3	steel	27000	210	7800	3.0×10^{-4}

(a) Assuming that g is 10 N/kg, calculate

(i) the mass of a steel cable of length 5.0 km,

mass = ρV
= ρ(*l*A)
= 7800 x 5000 x 3.0 x 10^{-4}
= 11 700 kg

mass = ………………………….. [2]

(ii) the minimum number of towers needed between the grid and the factory to support this steel cable.

weight of steel wire = mg
= 11700 x 10
= 117000 N

Minimum no of towers = (117000/27000) + 1
= 5.3
= 6
(answers 4, 5 or 6 are acceptable)

number = ……………………. [2]

(b) The 5.0 km cable used is actually made from aluminum and the current in it is 500 A.

For this cable, calculate

(i) the potential difference (p.d.) between the grid and the factory,

V = IR
= 500 x (0.075 x 5.0)
= 187.5 V
= 190 V

p.d. = ………………………… [1]

(ii) the power loss in the cable,

power loss = I^2R
= 500^2 x (0.075 x 5.0)
= 93750 W
= 94 000 W

Or

P = IV = 500 x 187.5 = 93750 W = 94 000 W

power loss = …………………… [1]

(iii) the cost each day of this power loss. 1 kWh costs 25 cents.

Cost = (93.750 kW) x (24 hours) x $0.25
= $562.50

cost = ………………. [2]

(c) Using data from the table, explain why aluminium is a more suitable material than copper for the cable, [2]

- **Aluminum is less dense than copper/its mass is smaller.**
- **With a smaller mass, lesser number of towers is needed to support the aluminum cable.**

10. Fig. 10 shows a refrigerator.

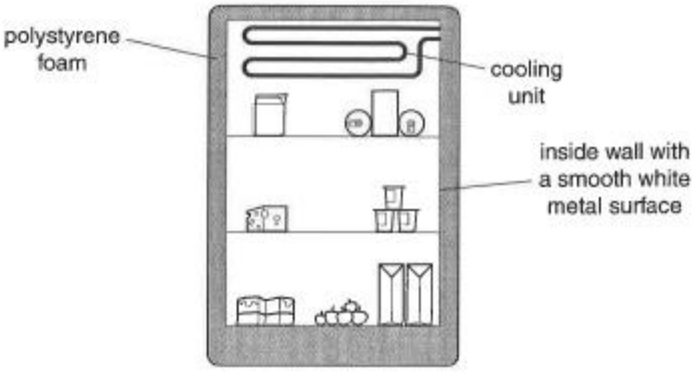

Fig. 10

(a) The refrigerator walls are made of smooth white metal with a layer of polystyrene foam between the inside and outside walls.

(i) Describe how the polystyrene foam insulates the refrigerator. [2]

- **The polystyrene foam contains pockets of trapped air, air is a poor conductor of heat**
- **The polystyrene foam reduces rate of heat transfer from surrounding to fridge by conduction.**

(ii) Explain how the cooling unit at the top sets up convection currents to cool all the contents of the refrigerator. [2]

- **The air near the cooling unit is colder, so it contracts, becomes denser and sinks.**
- **The warmer and less dense air at the bottom rises to replace the sinking cold air.**
- **In this way, convection currents are set up to cool the contents.**

(iii) A cup of liquid is placed in the refrigerator. The energy of the liquid decreases as it turns into a solid at the freezing point.
Explain, using ideas about molecules, why this decrease occurs. [1]

When a substance change from liquid to solid, the intermolecular bonds forms and energy is given out. Hence energy of liquid decreases.

(b) A beaker contains 500 g of water at a temperature of 50.0 ºC. An ice cube is removed from a refrigerator and dropped into the water. The ice cube is initially all solid at 0.0 ºC and has a mass of 3.0 g.

When the ice cube has melted, the water is stirred and has a temperature of 49.2 ºC.
The specific heat capacity of water is 4.2 J/(gºC).
Ignore the heat loss to the beaker and surroundings.

(i) Calculate the energy lost by the water as it cools from 50.0 ºC to 49.2 ºC.

energy lost = mcθ
= (500 x 4.2 x (50.0 – 49.2))
= 1680 J

energy = ……………………….. [2]

(ii) The melted ice (water) from the ice cube gains energy as it warms from 0.0 ºC to 49.2 ºC. Calculate the thermal energy needed for this rise in temperature.

energy needed = mcθ
= (3.0 x 4.2 x 49.2)
= 619.92 J
= 620 J

energy = ………………………… [1]

(iii) Use your answers to b(i) and b(ii) to determine the latent heat needed to melt the ice cube.

heat gained by ice = heat lost by water
$m_{ice}c\theta$ + latent heat to melt ice = $m_{water}c\theta$
619.92 + latent heat to melt ice = 1680

latent heat to melt ice = 1680 – 619.92
= 1060 J

energy = ………………………… [2]

11. EITHER

The stability of a box is tested, as shown in Fig. 11.1.

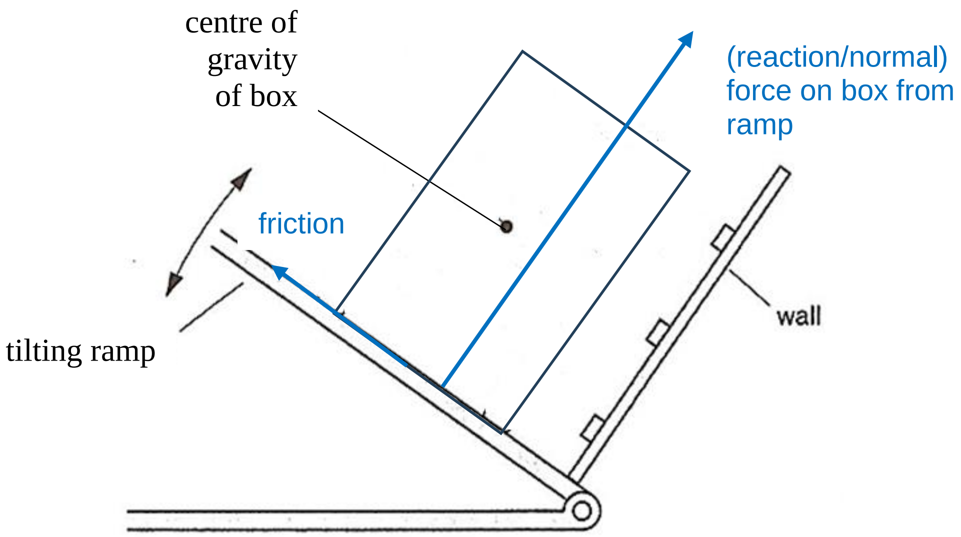

Fig. 11.1

The ramp is tilted as much as possible without the box falling over.
The ramp is then fixed and the box remains at rest in the position shown.

(a) State what is meant by *the centre of gravity*. [1]

The centre of gravity is the point through which its whole weight appears to act. [1]

(b) There are 3 forces acting on the box. Weight is one force acting on the box.

(i) On Fig. 11.1, draw 2 arrows to represent the remaining 2 forces acting on the box. Label your arrows with the names of the forces. [2]

(ii) Weight of the box is one force in an action-reaction pair. Describe the other force in the pair. [2]

- **force acting on the Earth by/from the box**
- **Upwards/opposite force or equal in magnitude.**

(iii) State two ways in which the two forces in an action-reaction pair are different. [2]

- **They are opposite in direction.**
- **They act on different bodies.**

(c) Explain why the box falls over if the ramp is titled any further. [2]

- **When the ramp is tilted further, the line of action of the weight of the box will fall outside the base area of the lorry.**
- **The weight of the lorry will generate a clockwise moment that will cause the lorry to topple over.**

(d) One factor that affects the stability of the box is the position of the centre of gravity. State how the position of the centre of gravity affects the stability of the box. [1]

The lower the CG, the more stable the box will be.

Or

The higher the CG, the less stable the box will be.

11. OR

Fig. 11.2 shows a ship using ultrasound to search for fish. A pulse of ultrasound is emitted at regular intervals downwards from the ship. Part of each pulse is reflected from the fish and part is reflected from the sea bed.

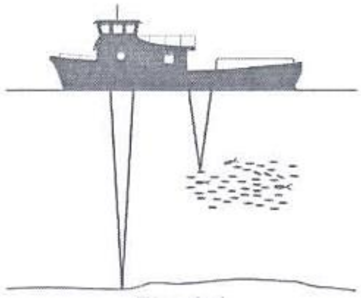

Fig. 11.2

(a) Compare the pulse reflected from the fish with the pulse reflected from the sea bed. [2]

- **Pulse from fish travels a shorter distance and returns sooner OR pulse from seabed travels a longer distance and returns later.**
- **Seabed is further away, thus pulse from seabed will have a smaller amplitude OR fish do not reflect all pulse and hence pulse has a smaller amplitude.**

(b) Suggest why the ear cannot detect ultrasound. [2]

- **Ultrasound is above the human hearing range**
- **which is greater than 20 000 Hz**

(c) Fig. 11.3 is a cathode-ray oscilloscope (c.r.o) trace of a pulse sent from the ship and the reflected pulse that returns from the sea bed.

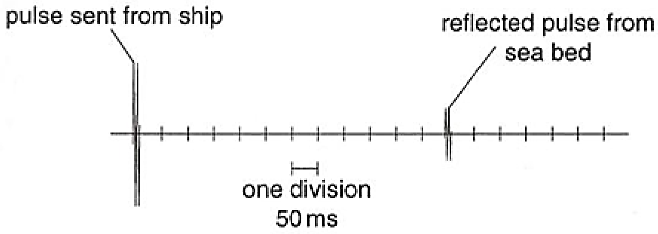

Fig. 11.3

The time-base setting for the x-axis is 50 ms/division. The speed of ultrasound in water is 1500 m/s.

Calculate

(i) the time taken for the pulse to travel from the ship to the sea bed,

time taken for 12 divisions = 50 x 10^{-3} x 12 = 0.60 s
time taken for pulse to travel from ship to the sea bed = 0.60 ÷ 2 = 0.30 s

time = ……………………… [1]

(ii) the depth of the sea bed.

depth = speed x time
= 1500 x 0.30
= 450 m

depth = …………………….. [2]

(d) Ultrasound and X-rays are both used in hospitals. When ultrasound is used, the nurse stays with the patient. When X-ray is taken, the nurse leaves the room.

(i) Explain in detail why it is sensible for the nurse to leave the room when X-ray is taken. [2]

X rays is ionizing radiation
that can cause cell death/cell damage/cancer/cell mutation.

(ii) With reference to the movement of the particles, describe one difference between ultrasound and X-ray. [1]

- **Particles in ultrasound vibrate parallel to the wave motion and**
- **Particles in X rays vibrate perpendicular to the wave motion.**

End of paper